1-2002

EFFECTS OF MANAGEMENT PRACTICES ON GRASSLAND BIRDS: HORNED LARK

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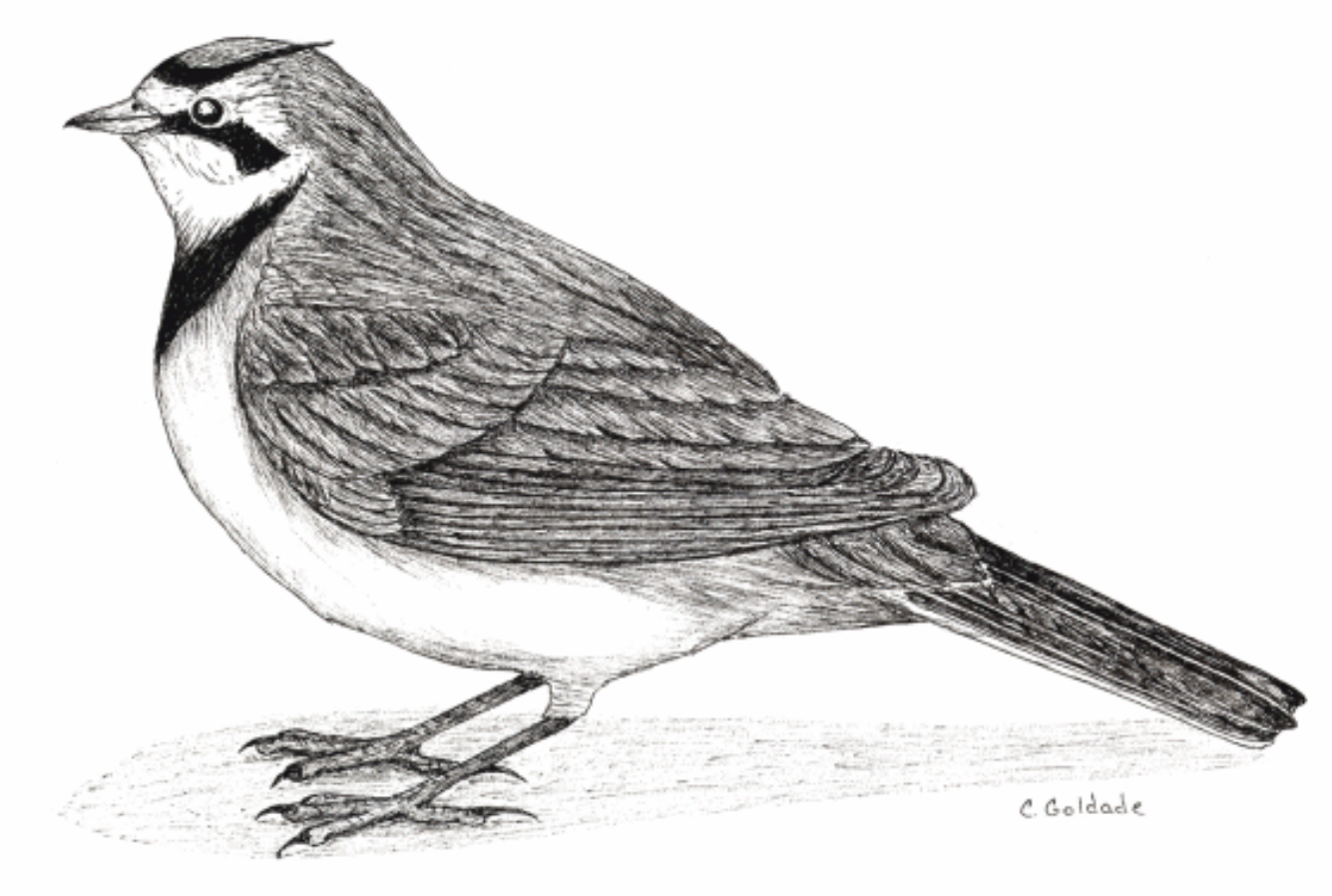

Grasslands Ecosystem Initiative
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This report is one in a series of literature syntheses on North American grassland birds. The need for these reports was identified by the Prairie Pothole Joint Venture (PPJV), a part of the North American Waterfowl Management Plan. The PPJV recently adopted a new goal, to stabilize or increase populations of declining grassland- and wetland-associated wildlife species in the Prairie Pothole Region. To further that objective, it is essential to understand the habitat needs of birds other than waterfowl, and how management practices affect their habitats. The focus of these reports is on management of breeding habitat, particularly in the northern Great Plains.

Suggested citation:

Dinkins, M. F., A. L. Zimmerman, J. A. Dechant, B. D. Parkin, D. H. Johnson, L. D. Igl, C. M. Goldade, and B. R. Euliss. 2000 (revised 2002). Effects of management practices on grassland birds: Horned Lark. Northern Prairie Wildlife Research Center, Jamestown, ND. 34 pages.

Species for which syntheses are available or are in preparation:

American Bittern
Mountain Plover
Marbled Godwit
Long-billed Curlew
Willet
Wilson's Phalarope
Upland Sandpiper
Greater Prairie-Chicken
Lesser Prairie-Chicken
Northern Harrier
Swainson's Hawk
Ferruginous Hawk
Short-eared Owl
Burrowing Owl
Horned Lark
Sedge Wren
Loggerhead Shrike
Sprague's Pipit
Grasshopper Sparrow
Baird's Sparrow
Henslow's Sparrow
Le Conte's Sparrow
Nelson's Sharp-tailed Sparrow
Vesper Sparrow
Savannah Sparrow
Lark Sparrow
Field Sparrow
Clay-colored Sparrow
Chestnut-collared Longspur
McCown's Longspur
Dickcissel
Lark Bunting
Bobolink
Eastern Meadowlark
Western Meadowlark
Brown-headed Cowbird

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HORNED LARK

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U.S. Geological Survey

Funding also provided by: U.S. Forest Service
The Nature Conservancy

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January 2000
(revised January 2002)

ORGANIZATION AND FEATURES OF THIS SPECIES ACCOUNT

Information on the habitat requirements and effects of habitat management on grassland birds were summarized from information in more than 4,000 published and unpublished papers. A ***range map*** is provided to indicate the relative densities of the species in North America, based on Breeding Bird Survey (BBS) data. Although birds frequently are observed outside the breeding range indicated, the maps are intended to show areas where managers might concentrate their attention. It may be ineffectual to manage habitat at a site for a species that rarely occurs in an area. The species account begins with a brief ***capsule statement***, which provides the fundamental components or keys to management for the species. A section on ***breeding range*** outlines the current breeding distribution of the species in North America, including areas that could not be mapped using BBS data. The ***suitable habitat*** section describes the breeding habitat and occasionally microhabitat characteristics of the species, especially those habitats that occur in the Great Plains. Details on habitat and microhabitat requirements often provide clues to how a species will respond to a particular management practice. A ***table*** near the end of the account complements the section on suitable habitat, and lists the specific habitat characteristics for the species by individual studies. A special section on ***prey habitat*** is included for those predatory species that have more specific prey requirements. The ***area requirements*** section provides details on territory and home range sizes, minimum area requirements, and the effects of patch size, edges, and other landscape and habitat features on abundance and productivity. It may be futile to manage a small block of suitable habitat for a species that has minimum area requirements that are larger than the area being managed. The Brown-headed Cowbird (*Molothrus ater*) is an obligate brood parasite of many grassland birds. The section on ***cowbird brood parasitism*** summarizes rates of cowbird parasitism, host responses to parasitism, and factors that influence parasitism, such as nest concealment and host density. The impact of management depends, in part, upon a species' nesting phenology and biology. The section on ***breeding-season phenology and site fidelity*** includes details on spring arrival and fall departure for migratory populations in the Great Plains, peak breeding periods, the tendency to renest after nest failure or success, and the propensity to return to a previous breeding site. The duration and timing of breeding varies among regions and years. ***Species' response to management*** summarizes the current knowledge and major findings in the literature on the effects of different management practices on the species. The section on ***management recommendations*** complements the previous section and summarizes specific recommendations for habitat management provided in the literature. If management recommendations differ in different portions of the species' breeding range, recommendations are given separately by region. The ***literature cited*** contains references to published and unpublished literature on the management effects and habitat requirements of the species. This section is not meant to be a complete bibliography; a searchable, annotated bibliography of published and unpublished papers dealing with habitat needs of grassland birds and their responses to habitat management is posted at the Web site mentioned below.

 Please direct comments and suggestions to Douglas H. Johnson, Northern Prairie Wildlife Research Center, U.S. Geological Survey, 8711 37th Street SE, Jamestown, North Dakota 58401; telephone: 701-253-5539; fax: 701-253-5553; e-mail: Douglas_H_Johnson@usgs.gov.

HORNED LARK
(*Eremophila alpestris*)

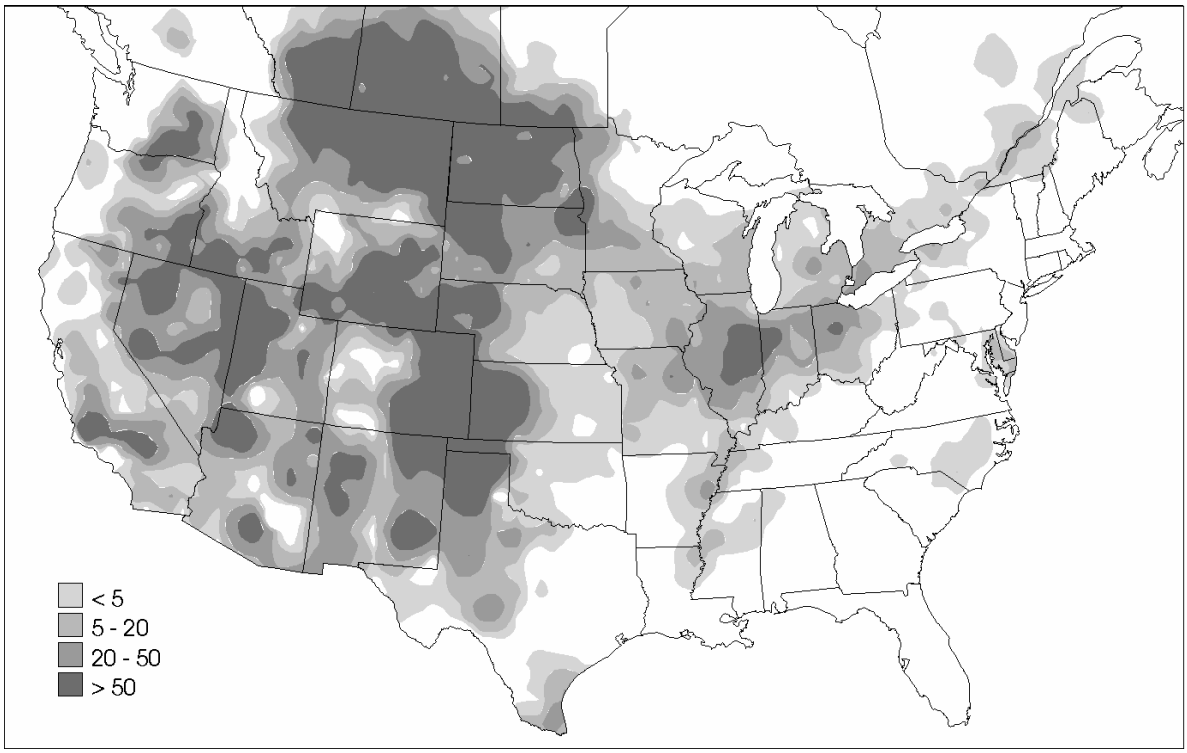

Figure. Breeding distribution of Horned Lark in the United States and southern Canada, based on Breeding Bird Survey data, 1985-1991. Scale represents average number of individuals detected per route per year. Map from Price, J., S. Droege, and A. Price. 1995. The summer atlas of North American birds. Academic Press, London, England. 364 pages.

Key to management is maintaining areas with short, sparse vegetation by burning, mowing, or grazing.

Breeding range:

There are 21 subspecies of Horned Lark (Beason 1995). Subspecies associated with the Great Plains include *E.a. enthymia*, *E.a. leucolaema*, and *E.a. praticola*. Horned Larks are year-round residents from southern British Columbia to southern Manitoba, south along the west coast of the United States to Mexico, and east to the east coast. Migratory populations of Horned Larks exist from northern British Columbia and Alaska, east to northern and eastern Quebec and Newfoundland, and also in southern Ontario and northern Michigan, Minnesota, and Wisconsin (National Geographic Society 1999). (See figure for the relative densities of the species in the United States and southern Canada, based on Breeding Bird Survey data.)

Suitable habitat:

Horned Larks prefer areas with short, sparse herbaceous vegetation with little or no woody vegetation (Beason 1970; Wiens 1973; Creighton 1974; Skinner 1974, 1975; Rotenberry and Wiens 1980; Dale 1983; Renken 1983; Sample 1989; Camp and Best 1993; Prescott and

Murphy 1996; Davis and Duncan 1999; Martin and Forsyth 2003). Preferred habitats include cropland, herbaceous fencerows, road rights-of-way, pasture, recently cut hayland, and shrubsteppe (Bent 1942; Cassel 1952; Graber and Graber 1963; Speirs and Orenstein 1967; Beason 1970; Strong 1971; Porter and Ryder 1974; Stewart 1975; Ducey and Miller 1980; Ryder 1980; Kantrud 1981; Best and Hill 1983; Faanes 1983; Gremaud 1983; Castrale 1985; Kahl et al. 1985; Greer 1988; Best et al. 1990; Bryan and Best 1991; Camp and Best 1993; Johnson and Schwartz 1993*a*; Hartley 1994*a,b*; Patterson 1994; Anstey et al. 1995; Faanes and Lingle 1995; Kerley and Anderson 1995; King and Savidge 1995; Kent and Dinsmore 1996; Patterson and Best 1996; Best et al. 1997; Davis et al. 1997; McMaster 1998; McMaster and Davis 1998; Martin and Forsyth 2003). Occupied areas are characterized by moderate coverage (10-37%) of bare ground (Speirs and Orenstein 1967, Skinner 1974, Dale 1983, Greer 1988, Sample 1989, Davis and Duncan 1999). Horned Larks may be present in newly seeded dense nesting cover (DNC) (Prescott and Murphy 1999), but relatively few if any Horned Larks were observed in established Conservation Reserve Program lands (CRP), Permanent Cover Program (PCP) lands, or DNC (Renken and Dinsmore 1987; Dale 1992, 1993; Johnson and Schwartz 1993*a,b*; Hartley 1994*a,b*; Johnson and Igl 1995; Patterson and Best 1996; Best et al. 1997). PCP was a Canadian program that paid farmers to seed highly erodible land to perennial cover; it differed from CRP in that haying and grazing were allowed annually in PCP.

In Colorado, Kansas, Montana, Nebraska, Oklahoma, Texas, and Wyoming, Horned Lark abundance was negatively correlated with percent forb cover, maximum vegetation height, and height of emergent forb and shrub cover (Rotenberry and Wiens 1980). In northcentral Colorado, mean vegetation measurements for occupied areas were 65% cover of short grasses (e.g., blue grama [*Bouteloua gracilis*] and buffalo grass [*Buchloe dactyloides*]), 2% cover of mid-grasses (e.g., slimspike three-awn [*Aristida longiseta*], western wheatgrass [*Pascopyrum smithii*], little bluestem [*Schizachyrium scoparium*]), 6% sedge (*Carex* spp.) cover, 7% forb cover, 2% cactus cover, 0.8% shrub cover, 17% bare ground, 1% rock cover, and 7.2 cm mean vegetation height (Creighton 1974). In another Colorado study, Bock et al. (1999) compared the abundance of Horned Larks between upland (mixed-grass prairie) and lowland (tallgrass prairie or tame hayland) grassland plots. Horned Larks were significantly more abundant on upland than on lowland plots. In mixed-grass pastures in North Dakota, Horned Lark density was higher in pastures with <10% cover of western snowberry (*Symphoricarpos occidentalis*) and silverberry (*Elaeagnus commutata*) than in pastures with 30-80% cover of these shrubs (Arnold and Higgins 1986). The highest densities of Horned Larks occurred on transects with the lowest height and density of vegetation, regardless of the presence or absence of shrubs. Horned Larks in Saskatchewan occupied areas having little or no vegetation or litter (Dale 1983, Davis and Duncan 1999). Based on vegetation at nest sites in Saskatchewan, Horned Lark occurrence was positively associated with number of contacts of narrow-leaved (<5 mm wide) grasses $\leq$10 cm high and was negatively associated with vegetation height (SWCC 1997). In Alberta, the species preferred short grass that was uniform in height (Prescott and Murphy 1996).

Breeding habitat in Missouri cropland consisted of shallow (<0.4 cm), sparse (<25%) litter cover, short (<10 cm) vegetation, and no woody stems (Kahl et al. 1985). Skinner (1974) found that Horned Larks in Missouri used areas of bare ground caused by cattle and American bison (*Bison bison*) disturbances. In Illinois, pasture and alfalfa (*Medicago sativa*) hayland were used only in early spring (prior to 5 May), when vegetation was short and sparse (Gremaud 1983). In Illinois cropland, territory density was highest in hay stubble or corn stubble fields than in plowed fields (Beason and Franks 1974). Beason (1970) found territories were densest in

disced cropland and recently cut hayfields (with vegetation heights of about 10 cm). Nests in cropland and hayland were placed on the ground in depressions, usually on the leeward side of a protective tuft of grass, rock, or other object in a barren area. Nests in Colorado often were found near cowpies (Porter and Ryder 1974, Ryder 1980, With and Webb 1993). Nests in North Dakota occurred in shallow depressions on bare or sparsely vegetated ground (Stewart 1975). In Iowa, the use of rowcrop fields significantly increased as their proximity to woody habitats decreased (Gremaud 1983). Horned Larks were common in strip-intercropped fields (i.e., planting rowcrops, legumes, and small grains in a series of adjacent, narrow strips) in Iowa (Stallman and Best 1996). In Nebraska, Horned Larks were absent from areas of extensive corn production, possibly because the timing of crop planting disrupted nesting activity (Faanes and Lingle 1995). Horned Larks in Indiana preferred conventionally tilled (fields tilled in the spring prior to planting) fields over no-tillage fields (fields untilled between harvest and planting with seed planted directly into crop residue) (Castrale 1985). In Alberta, short vegetation appeared to be a factor in early-season preference for cropland (Martin and Forsyth 2003). Short vegetation also was associated with higher numbers of productive territories and higher productivity when compared to areas of taller vegetation. Breeding territories were observed in both spring- and winter-wheat fields regardless of whether conventional or conservation tillage was used. Conventional tillage was defined as multiple cultivations prior to planting; conservation tillage was defined as planting directly into the previous year's stubble. A table near the end of the account lists the specific habitat characteristics for Horned Larks by study.

Area requirements:

In Colorado, Horned Lark territories in lightly grazed shortgrass pastures ranged from 0.3 to 1.5 ha and averaged 0.7 ha (Boyd 1976). Territories in heavily summer- and winter-grazed shortgrass pastures in Colorado ranged from 1.0 to 1.7 ha and averaged 1.5 ha (Wiens 1970, 1971). Territories in mixed-grass pasture and idle mixed-grass averaged 1.1 ha and 1.6 ha, respectively (Wiens 1971). In midwestern cropland, territory sizes ranged from 0.6 to 3.1 ha with an average of 1.6 ha (Beason and Franks 1974). Territory sizes in disced cropland and tame hayland ranged in size from 1.0 to 2.5 ha (Beason 1970). Bent (1942) reported a Horned Lark territory in Illinois that was only 81 m^2 (0.008 ha). In tallgrass prairie fragments in Illinois, Horned Larks were found in patches <10 ha (Herkert 1991).

No studies have investigated a relationship between patch size and nest success or patch size and rates of brood parasitism by Brown-headed Cowbirds (*Molothrus ater*). Bock et al. (1999) compared the abundance of Horned Larks between interior and edge locations. Edge was defined as the interface between suburban development and upland or lowland habitat, and interior locations were 200 m from edge. Horned Larks occurred more frequently on interior plots than on edge plots but the difference was not significant due to high variation in numbers of Horned Larks among plots.

Brown-headed Cowbird brood parasitism:

The Horned Lark is an infrequent victim of the Brown-headed Cowbird (Friedmann 1963, Friedmann et al. 1977). Parasitism rates vary from 0% of 163 nests (Maher 1973) to 60% of 84 nests (Koford et al. 2000). Refer to Table 1 in Shaffer et al. (2003) for rates of cowbird brood parasitism. Horned Larks may be multiply-parasitized (Peabody 1899, Robbins 1949, Friedmann 1963, SWCC 1997, Koford et al. 2000). In Kansas and North Dakota, parasitism in initial clutches may have been less than in subsequent clutches because first clutches were laid

before the onset of the breeding season of Brown-headed Cowbirds (Hill 1976, Koford et al. 2000). In North Dakota, no early nests (discovered prior to 15 May) were parasitized, but 50 of 84 (60%) nests found after 15 May were parasitized (Koford et al. 2000). No parasitism was observed in eight initial clutches laid from mid-March to mid-April in western Kansas, but 14 of 22 second clutches were parasitized from mid-May to mid-June (Hill 1976). In the Great Plains, the breeding season of the Brown-headed Cowbird generally extends from early May to late July and peaks from late May to mid-July (Stewart 1975, Ortega 1998).

Breeding-season phenology and site fidelity:

Horned Larks may be year-round residents in all but the most northern parts of their breeding range (Beason 1995). Horned Larks begin arriving on their breeding range in large numbers from late February to late March and depart from late October to late November (Maher 1973, Stewart 1975, Salt and Salt 1976, Faanes 1981, Janssen 1987). Peak nesting in North Dakota occurred from late April to late July (Stewart 1975). Dubois (1935) noted two peaks in nesting activity in Montana, one at the end of April and another in early June. Peak nesting activity in Colorado occurred from April to early May (Creighton 1974). The species has exhibited both breeding-site and mate fidelity (George 1952, Ryder 1972, Boyd 1976). In Michigan, six of 12 banded adults returned as breeders the year following banding (George 1952). In Colorado, six of 15 banded adults were recaptured at the banding site the following year (Ryder 1972). Two banded males returned to the same study area the year following banding, but held different territories. In another Colorado study, 23 of 35 females and 23 of 36 males returned the year following banding (Boyd 1976). An additional two males were present on the previous year's territories in February and March but may have perished in a March snowstorm. Only one of the 23 males did not use the same territory as was used the previous year. Almost one half of the 23 returning females returned to the same mate the year following banding. Six of 136 Horned Larks marked as juveniles returned to breed on the study area. Also in Colorado, a male Horned Lark was resighted six years later in the same general area in which he was banded (Clapp et al. 1983).

Horned Larks raise up to three broods per season (Peabody 1899; George 1952; Maher 1973, 1974; Porter and Ryder 1974; Boyd 1976; Salt and Salt 1976). In Saskatchewan, the average number of clutches produced per female was estimated at two or three; some individuals produced up to five clutches (Maher 1973). Renesting is common after the failure of an initial nesting attempt (George 1952, Maher 1973).

Species response to management:

Horned Larks were present in South Dakota mixed-grass areas 1 mo postburn but were absent from unburned areas (Huber and Steuter 1984). In native rough fescue (*Festuca scabrella*) grasslands in Saskatchewan, breeding Horned Larks were present in low numbers (ranging from 0.02 to 0.06 birds/ha) in both a fall-burned plot and an unburned plot (Pylypec 1991). In Saskatchewan mixed-grass prairie that was burned in late summer, peak densities of Horned Larks were recorded 2 yr postburn (Maher 1973). In Wyoming, Kerley and Anderson (1995) observed Horned Larks in burned shrubsteppe.

In North Dakota, Horned Larks avoided a mixed-grass hayland that had been mowed during the previous year (Kantrud 1981). Horned Larks were not present in Colorado hayland, which had been flood-irrigated during spring and early summer, mowed during July, and occasionally grazed by cattle during fall and winter (Bock et al. 1995, Bock et al. 1999). In

Illinois, Horned Larks were present in hayland composed of a mixture of native and tame vegetation (Graber and Graber 1963). Horned Larks in another Illinois study were common in a tame hayfield (vegetation height was <10 cm) early (March through May) in the breeding season, but abandoned the hayfield by early June, presumably due to the growth of vegetation (Beason 1970). Horned Larks became abundant in the hayfield after it was cut (vegetation height after cutting was 10-15 cm) in mid-June, although it appeared that no territories were established. By early July, vegetation in the hayfield had grown to 40 cm tall and the birds abandoned the field. Horned Larks occurred in tame hayland in Minnesota and Wisconsin (Faanes 1981). In Saskatchewan, Horned Larks were common in hayland that was mowed once annually in July; surveys were conducted just prior to mowing (Dale et al. 1997).

In shortgrass pastures in Colorado, Horned Larks preferred heavily grazed over lightly or moderately grazed pastures (Giezentanner and Ryder 1969; Ryder and Cobb 1969; Giezentanner 1970*a*,*b*; Ryder 1980). Wiens (1970) found that Horned Larks in Colorado preferred heavily winter-grazed sites over heavily summer-grazed sites for breeding. In North Dakota mixed-grass prairie, Horned Larks were found on twice-over rotation pastures, short-duration pastures, and season-long grazing pastures (Messmer 1990). Short-duration grazing involved a system of pastures rotated through a grazing schedule of about 1 wk grazed and 1 mo ungrazed, repeated throughout the season. Twice-over rotation involved grazing a number of pastures twice per season, with about a 2-mo rest in between grazing. Horned Larks preferred silty range sites that were characterized by loamy soils, 1-15% slope, mean grass coverage ranging from 17 to 65%, low shrub cover, and moderate to high litter cover; maximum vegetation height ranged from 50 to 70 cm and average litter depth ranged from 3.8 to 9.1 cm. Horned Larks also were present in shallow-to-gravel sites that were characterized by shallow, coarse-textured soil, sparse cover, and reduced litter. In North Dakota, areas mowed or grazed by sheep had fewer shrubs than areas not mowed or grazed; Horned Larks preferred these areas because of reduced shrub density (Higgins 1986). In Missouri, Horned Larks were most common in heavily grazed native or tame pastures, followed by moderately grazed pastures; they were absent from idle grasslands and haylands (Skinner 1974, 1975; Skinner et al. 1984). Vegetation that was >30 cm tall was avoided. In Saskatchewan, nests were observed in moderately to heavily grazed shortgrass (Strong 1971). Anstey et al. (1995) in Saskatchewan and Prescott (1997) in Alberta found that Horned Larks preferred mixed-grass pastures over tame pastures. No preference, however, was exhibited between mixed-grass pastures and tame pastures in other studies from Alberta and Saskatchewan (Prescott and Wagner 1996, Davis et al. 1997, Sutter and Brigham 1998, Davis and Duncan 1999).

Horned Larks are more common in cropland than in CRP (Johnson and Schwartz 1993*a*, Patterson 1994, Johnson and Igl 1995). Horned Larks were not observed in CRP in Indiana, Iowa, Kansas, Michigan, Missouri, and Nebraska (Patterson 1994, Best et al. 1997). Horned Larks in Minnesota, Montana, North Dakota, and South Dakota were most frequently observed in CRP that had been planted to native grasses (Johnson and Schwartz 1993*b*). They were less frequently observed in CRP fields planted to introduced grasses and legumes, and were absent from wildlife food plots and tree plantings. Horned Larks were absent from tame DNC and idle mixed-grass in North Dakota (Renken and Dinsmore 1987). In Alberta, Horned Larks were present in newly seeded DNC (Prescott and Murphy 1999). In Saskatchewan, Horned Larks were not present in DNC or were present in low numbers compared with low nesting cover (bluegrass [*Poa*]/fescue [*Festuca*] mixture) and idle mixed-grass prairie (Dale 1992,1993; Hartley 1994*a*,*b*). Also in Saskatchewan, Horned Larks were more abundant in cropland on

conventional, minimum-tillage, and organic farmland than in DNC (Shutler et al. 2000). Presence of Horned Larks was negatively related to number of wetlands within 2.8 km^2 of point counts and by area of woody vegetation. Horned Larks were not detected in wetlands or wetland margins. Horned Larks were common in PCP, but occurred significantly more frequently in cropland (McMaster 1998, McMaster and Davis 1998). The frequency of occurrence of Horned Larks in PCP was significantly higher in grazed PCP sites than in hayed PCP sites.

Horned Lark densities in Colorado, Idaho, North Dakota, Utah, and Wyoming were not influenced by use of malathion, carbaryl in oil, and carbaryl bait for grasshopper (Orthoptera) control (George et al. 1995). At the Pawnee National Grassland in Colorado, malathion and toxaphene were applied at rates of 0.6 kg/ha and 1.1 kg/ha, respectively (McEwen and Ells 1975). Densities of Horned Larks were about 1 pair per ha before application of insecticides. Seventeen days after application, numbers of Horned Larks decreased about 30% on toxaphene plots, but remained stable on malathion and untreated plots. Nestlings were killed by toxaphene applications. Mean toxaphene level of 13 Horned Larks collected between 1 and 28 d postspray for analysis of residue was 5.4 parts per million (ppm). At 58 d, two birds had toxaphene residues of 4.6 and 4.1 ppm. At 85 d, two birds had toxaphene residues of 2.3 and 2.9 ppm. Two dead meadowlarks contained toxaphene residues of 4.5 and 2.7 ppm. On malathion plots, only Horned Larks collected through 31 hr postspray contained measurable ($\geq$0.4 ppm) whole-body residues. Four Horned Larks from the untreated area contained 0.5 to 2.0 ppm toxaphene, indicating insecticide drift. No malathion residue was found in two birds from untreated plots. In New Mexico, toxaphene applied at 1.1 kg/ha caused mortality in Horned Larks and a decline in numbers (McEwen et al. 1972). No effects were observed from applications of 448 g/ha carbaryl or 476 g/ha malathion. Horned Larks numbers declined significantly on guthion-treated plots at the 280 g/ha application.

In Montana, numbers of Horned Larks were unaffected by application rates of 175 g/ha of BAY 77488*[1] (phenylglyoxylonitrile oxime 0,0-diethyl phosphorothioate) (McEwen et al. 1972). Rates of 322 and 651 g/ha caused significant declines in Horned Lark numbers between pre- and post-spray censuses. Horned Lark numbers declined significantly on areas sprayed with 441 and 672 g/ha applications of fenitrothion. In Wyoming, diazinon applied at 350-560 g/ha caused mortality in Horned Larks and a significant decline in numbers (McEwen et al. 1972). No significant declines in Horned Larks were caused by Mobam* (benzo [b]thien-4-yl methylcarbamate) applied at a rate of 210 g/ha. In Montana and Wyoming, numbers did not decline significantly with 140, 210, or 280 g/ha rates of Baygon* (*o*-isopropoxyphenyl methylcarbamate) (McEwen et al. 1972). In Wyoming, Horned Lark mortality was observed after fenthion, a chemical used to control mosquitoes (Culicidae), was aerially applied at a rate of 47 g/ha to an irrigated meadow (DeWeese et al. 1983). Applications of chlorpyrifos on wheat fields (applied at rates of 1.0 kg in 18.9 L water/ha and 0.56 kg in 18.9 L water/ha) in Montana resulted in reduced cholinesterase activity in the brains of Horned Larks compared to a control group (McEwen et al. 1986).

Numbers of Horned Larks in Wyoming shrubsteppe were significantly higher in areas that were treated 20-22 yr previous to the study with 2,4-D to remove sagebrush than in untreated (i.e., unburned and not sprayed with herbicides) areas (Kerley and Anderson 1995).

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*References to chemical trade names does not imply endorsement of commercial products by the Federal Government.

Untreated areas contained higher shrub density, higher percent shrub cover, and taller shrubs than treated areas. Grazing intensity also was lower on untreated areas. In Ontario corn fields, the mean number of Horned Larks did not differ between pre- and post-applications of the granular insecticides fonofos and terbufos, which are used to control corn rootworm (*Diabrotica* spp.), or between treated fields and control fields (Knapton and Mineau 1995). In areas managed for lowbush blueberries (*Vaccinium angustifolium*) in Maine, Horned Larks were present only in areas recently sprayed with the herbicide hexazinone at a rate of 4 kg/ha (Vickery 1993). Horned Larks preferred the sparse vegetation cover.

Clark and Karr (1979) studied the effects of roads and interstate highways on the density of Horned Larks in central Illinois. They found that the density of Horned Larks increased with distance from the road or highway. In a Saskatchewan study that examined whether the abundance of grassland birds differed between roadsides and trailsides, abundance of Horned Larks was not significantly different along trailsides than along roadsides (Sutter et al. 2000). Roads were defined as traveling surfaces with adjacent drainage ditches planted to smooth brome (*Bromus inermis*) and ending with a fence 11-18 m from the traveling surface. Trails were defined as a single pair of wheel ruts visually indistinct from surrounding habitat in terms of plant structure and composition. Habitat along roads and trails were parcels of lightly to moderately grazed native prairie >256 ha.

Management recommendations:

Burn in the spring to reduce woody species (Skinner et al. 1984).

Burning, mowing, or grazing can be used interchangeably to create short, sparse vegetation that Horned Larks prefer (Skinner 1974, 1975; Huber and Steuter 1984; Skinner et al. 1984).

Control shrub growth in mixed-grass pastures in North Dakota by allowing mowing or grazing by sheep (Arnold and Higgins 1986).

In mesic areas, allow moderate grazing to increase habitat patchiness and bird diversity (Skinner 1974, 1975; Ryder 1980; Skinner et al. 1984).

When pest management is required, use only rapidly degrading chemicals of low toxicity to nontarget organisms and apply at the lowest application rates possible (McEwen et al. 1972). Avoid pest outbreaks by maintaining range in good condition. Overgrazed and drought-affected areas tend to be more prone to insect outbreaks.

Reduce amount of grassland edge near suburban interfaces (Bock et al. 1999).

Road construction plans should consider the effects of roads on bird densities in rights-of-way and $\leq$500 m from rights-of-way (Clark and Karr 1979).

Table. Horned Lark habitat characteristics.

Author(s)	Location(s)	Habitat(s) Studied*	Species-specific Habitat Characteristics
Anstey et al. 1995	Saskatchewan	Cropland, mixed-grass pasture, tame hayland, tame pasture	Were observed most frequently in cropland; preferred native over tame pastures; preferred moderately and heavily grazed pastures; abundance was negatively associated with shrubs and dead vegetation 20-100 cm tall
Arnold and Higgins 1986	North Dakota	Mixed-grass hayland, mixed-grass pasture	Occurred at higher densities in areas with <10% cover of western snowberry (*Symphoricarpos occidentalis*) and silverberry (*Elaeagnus commutata*) than in pastures with 30-80% cover of these shrubs; highest densities occurred in heavily grazed areas of low height/density, regardless of the presence or absence of shrubs
Beason 1970	Illinois	Cropland, tame hayland	Territory density was highest in disced cropland and an alfalfa (*Medicago sativa*) hayfield (vegetation height in the hayfield was about 10 cm); by early June, the hayfield was abandoned, presumably due to the growth of vegetation; the hayfield was recolonized after the hay was cut (to about 10 or 15 cm) in mid-June, although no territories were established at this time; by early July, vegetation in the hayfield had grown to 40 cm and the field was abandoned
Beason and Franks 1974	Illinois	Cropland, hayland, idle tame	Occurred at higher densities in hay stubble or corn stubble than in plowed fields
Best and Hill 1983	Iowa	Cropland	Occurred in herbaceous fencerows in the spring and summer

Best et al. 1997	Indiana, Iowa, Kansas, Michigan, Missouri, Nebraska	Conservation Reserve Program (CRP; burned seeded-native, burned seeded-native/tame, burned tame, idle seeded-native, idle tame/seeded-native, idle tame, seeded-native/tame hayland, tame hayland), cropland	Nested in rowcrop fields but not in CRP
Bock et al. 1995, Bock et al. 1999	Colorado	Idle mixed-grass, idle tallgrass, mixed-grass pasture, tallgrass pasture, tame hayland	Were present in uplands and absent from tallgrass or hayland; hayland had been flood-irrigated during spring and early summer, mowed during July, and occasionally was grazed by cattle during fall and winter
Boyd 1976	Colorado	Shortgrass pasture	Sang from road centers, cowpies, or fence posts; smallest territories were associated with an area that had a level playa and consisted of medium and fine textured soil; vegetation in this shortgrass habitat included blue grama (*Bouteloua gracilis*), buffalo grass (*Buchloe dactyloides*), scattered clumps of slimspike three-awn (*Aristida longiseta*), and shrubs; ground nests were sheltered by vegetation (e.g., grama [*Bouteloua*], three-awn [*Aristida*], rabbitbrush [*Chrysosamnus*], and prickly pear [*Opuntia*]) or cowpies
Bryan and Best 1991	Iowa	Cropland, idle tame, tame hayland	Densities were higher in grassed waterways than in cropland
Camp and Best 1993	Iowa	Burned seeded-native	Were common in roadsides; abundance in roadsides

		tallgrass/tame, burned tame, cropland, idle seeded-native tallgrass/tame, idle tame	increased with greater forb cover
Cassel 1952	Colorado	Montane meadow, shortgrass pasture, shrubsteppe, woodland	Were found in heavily grazed blue grama; occurred in a wide variety of habitats, from plains to alpine meadow
Castrale 1985	Indiana	Cropland	Occurred in conventionally tilled cropland but not in untilled cropland
Creighton 1974	Colorado	Mixed-grass pasture, shortgrass pasture	Nesting habitat was characterized by sparse vegetation dominated by buffalo grass and blue grama; mean vegetation values for occupied areas were 65% shortgrass (e.g., blue grama and buffalo grass) cover, 2% mid-grass (e.g., western wheatgrass [*Pascopyrum smithii*], slimspike three-awn, little bluestem [*Schizachyrium scoparium*], needle-and-thread [*Stipa comata*]) cover, 6% sedge (*Carex* spp.) cover, 7% forb cover, 2% cactus cover, 0.8% shrub cover, 17% bare ground, and 1% rock cover ; mean vegetation height was 7.2 cm; nests were not covered by vegetation
Dale 1983, 1984	Saskatchewan	Idle mixed-grass, mixed-grass pasture	Consistently chose areas of sparse, low vegetation in grazed areas; grazing reduced density and height of vegetation, which made habitat available earlier in the breeding season, created favorable thermal conditions, and provided foraging, displaying, and nesting needs; occupied areas were characterized by 5.6 vertical vegetation contacts, 5.5 vegetation contacts in first 10 cm, 3.4 cm forb height, 1.0 vegetation contacts in last 10 cm, 4.9 mm litter

			depth, 20.5% dwarf shrub cover, 41.5 cm distance to nearest forb, and 9.8% bare ground cover
Dale 1992	Saskatchewan	Dense Nesting Cover (DNC; idle seeded-native, idle tame), idle native, idle native/tame, tame hayland	Were more common in bluegrass (*Poa*)/fescue (*Festuca*) than in tame DNC grasslands
Dale 1993	Saskatchewan	DNC (idle tame), idle, low nesting cover (idle tame)	Were observed in fallow fields; significantly more Horned Larks occurred in low nesting cover than in DNC
Dale et al. 1997	Saskatchewan	Idle mixed-grass, idle tame, tame hayland	Occurred frequently in native grassland and in annually hayed fields
Davis and Duncan 1999	Saskatchewan	Mixed-grass pasture, tame pasture	Were equally frequent in native pastures as in tame pastures (crested wheatgrass [*Agropyron cristatum*]); occurrence in native or tame pastures was positively associated with bare ground and fringed sagewort (*Artemisia frigida*) and negatively associated with vegetation height, litter depth, thick-spike wheatgrass (*Agropyron dasystachyum*), and western snowberry
Davis et al. 1997	Saskatchewan	Cropland, hayland, mixed-grass pasture, tame pasture	Were more abundant in cropland than in hayland, mixed-grass pasture, or tame pasture; species was equally abundant in tame pasture and native pasture
Ducey and Miller 1980	Nebraska	Cropland, idle, mixed-grass pasture, tame hayland	Were observed in soybean and corn fields
Faanes 1981	Minnesota, Wisconsin	Cropland, idle, idle tallgrass/tame, shrub	Used agricultural areas, such as hayfields, oat stubble fields with very short vegetation, bare

		carr, tame hayland, tame pasture, wet meadow, wetland, woodland	cultivated areas, and rowcrops
Faanes 1983	North Dakota	Idle mixed-grass, mixed-grass pasture, woodland	Nested in moderately to heavily grazed native pastures and in fallow cropland adjacent to wooded draws
Faanes and Lingle 1995	Nebraska	Cropland, idle mixed-grass, idle shortgrass, idle tallgrass, pasture, tame hayland, wet meadow, wetland, woodland	Nested in upland prairie, wheat, alfalfa, corn, and wet prairie; were largely absent from areas of extensive corn production, possibly because the timing of crop planting disrupted nesting activity
Giezentanner 1970*a*,*b*	Colorado	Cropland, hayland, idle, shortgrass pasture	Were found in both summer and winter pastures that were grazed at heavy, moderate, and light levels; heavy grazing removed 60% of the annual plant growth and resulted in pastures of uniform height; moderate grazing removed 40% of the annual plant growth and resulted in patches of grazed and ungrazed areas; and light grazing removed 20% of the annual plant growth and resulted in patches of heavy grazing surrounded by areas of little or no grazing; were most common in the heavily summer-grazed area with sparse vegetation 2.5-5.1 cm high
Giezentanner and Ryder 1969	Colorado	Shortgrass pasture	Were most abundant on heavily and moderately summer-grazed pastures
Graber and Graber 1963	Illinois	Cropland, hayland, idle, idle grassland, tame pasture, wetland, woodland	Density was highest in plowed fields, followed by fields of alfalfa, red clover (*Trifolium pratense*), soybean, corn, yellow sweet clover (*Melilotus officinalis*), small-grain stubble, oats, ungrazed

			grassland, fallow, pastures, or hayland; as amount of acreage in cropland increased, Horned Larks used more cropland
Greer 1988	Wyoming	Mixed-grass pasture	Nest sites were characterized by mean values of 22% lichen cover, 2% cowpie cover, 8% forb cover, 7% shrub cover, 1% cactus cover, 37% bare ground cover, 26% mixed-grass (e.g., needle-and thread grass, western wheatgrass, Junegrass [*Koeleria pyramidata*], Indian ricegrass [*Oryzopsis hymenoides*], and bluegrasses [*Poa* spp.]) cover, 15% litter cover, 23% shortgrass (e.g., blue grama) cover; 23% plant cover in first 5 cm; 1.4 total vegetation contacts; 61% of 21 nests were placed on the leeward side of shrubs
Gremaud 1983	Iowa	Cropland, tame hayland, tame pasture, woodland	Abundance was higher in rowcrop than in herbaceous habitats; use of rowcrops significantly increased as the proximity to woody habitats (woodland or brush) decreased; pastures and alfalfa hayfields received little use once vegetation began to grow following grazing or haying
Griebel et al. 1998	Nebraska	Burned mixed-grass pasture, mixed-grass pasture	Relative abundance did not differ between a burned area grazed by American bison (*Bison bison*) and areas grazed by cattle; within bison pastures, Horned Lark abundances were not significantly different between burned and unburned areas
Hartley 1994*a*,*b*	Saskatchewan	Cropland, DNC (idle seeded-native, idle seeded-native/tame, idle tame, idle tame hayland), idle mixed-	Were found in idle mixed-grass and cropland; more common in cropland than in idle mixed-grass; absent from DNC

		grass	
Johnsgard 1980	Nebraska	Cropland, idle, idle mixed-grass, idle shortgrass, idle tallgrass, mixed-grass pasture, tallgrass pasture	Were found in native grasslands and cultivated fields
Johnson and Igl 1995, Johnson and Schwartz 1993*a*	Minnesota, Montana, North Dakota, South Dakota	Cropland, CRP (idle seeded-native, idle tame)	Were more common in cropland than in CRP
Johnson and Schwartz 1993*b*	Minnesota, Montana, North Dakota, South Dakota	Cropland, CRP (idle seeded-native, idle tame)	Densities were higher in CRP planted to native grasses than in CRP planted to tame grasses
Jones 1994	Manitoba	Cropland, DNC (idle seeded-native, idle tame), idle mixed-grass, idle tame, tame hayland, woodland	Observed in highest abundance in cropland; also found in hayland and idle mixed-grass
Kahl et al. 1985	Missouri	Burned tallgrass, cropland, idle, idle tallgrass, tallgrass hayland, tallgrass pasture, woodland, woodland edge	Were found only in agricultural habitats; occupied habitat had shallow (<0.4 cm) litter, short (<0.10 m) ground vegetation, no woody stems, and sparse (<25%) litter cover
Kantrud 1981	North Dakota	Mixed-grass hayland, mixed-grass pasture	Avoided hayland that was mowed the previous year; were most abundant in heavily grazed pasture
Kantrud and Kologiski	Colorado,	Mixed-grass pasture,	Were most common in heavily grazed borollic

1982	Montana, Nebraska, North Dakota, South Dakota, Wyoming	shortgrass pasture, shrubsteppe	aridisol soils, which were characterized by light coloration, low organic matter, and low moisture content during the growing season
Karasiuk et al. 1977	Alberta	Mixed-grass pasture	Observed in heavily grazed areas
Kent and Dinsmore 1996	Iowa	Cropland, pasture	Nested in pasture and cropland
King and Savidge 1995	Nebraska	Burned tallgrass, cropland, CRP (burned seeded-native, idle seeded-native, idle tame, tame hayland), idle tallgrass, tallgrass hayland	Observed only in cropland
Maher 1973	Saskatchewan	Burned mixed-grass, idle mixed-grass, mixed-grass hayland, mixed-grass pasture	Density was three times higher in grazed than ungrazed grassland; in ungrazed grassland, maintained relatively constant density between five seasons; in burned grassland, highest density occurred 2 yr postburn
Maher 1974	Saskatchewan	Cropland, idle mixed-grass, mixed-grass pasture, tame hayland, woodland	Very common summer resident and occasional permanent resident on grazed and ungrazed grassland
Martin and Forsyth 2003	Alberta	Cropland, idle	Breeding territories were established in almost every spring-wheat field in both years, regardless of whether conventional tillage or conservation tillage was used; conventional tillage was defined as multiple cultivations prior to planting; conservation

			tillage was defined as planting directly into the previous year's stubble; breeding territories were established in most winter-wheat fields under both tillage regimes at some point during the season; breeding territories were established in almost every fallow field in both years, regardless of tillage regime; early-season use of fields, number of productive territories, and productivity were negatively correlated with vegetation height
McMaster 1998, McMaster and Davis 1998	Alberta, Manitoba, Saskatchewan	Cropland, Permanent Cover Program (PCP; idle tame, tame hayland, tame pasture)	Were common within PCP sites but occurred significantly more frequently in cropland; frequency of occurrence was significantly higher in grazed PCP sites than in hayed PCP sites
Messmer 1990	North Dakota	Idle mixed-grass/tame, mixed-grass/tame hayland, mixed-grass/tame pasture, wet-meadow pasture	Density was higher on the twice-over rotation grazing system than short-duration grazing, season-long grazing, and idle; no density differences were exhibited among treatments 4 yr later; were found on silty range sites or shallow-to-gravel sites of grazed pastures; silty range sites were characterized by mean values of 17-65% grass cover, 1-4% shrub cover,18-59% litter cover; 50-70 cm maximum vegetation height and 3.8-9.1 cm litter depth; shallow-to-gravel range sites were characterized by sparse cover and reduced litter
Owens and Myres 1973	Alberta	Cropland, idle mixed-grass, mixed-grass hayland, mixed-grass pasture	Nested only in cultivated and grazed areas
Patterson 1994, Patterson and Best 1996	Iowa	Cropland, CRP (idle tame, tame hayland)	Nested in rowcrop fields; were not present in CRP, nor were any nests found in CRP

Porter and Ryder 1974	Colorado	Shortgrass pasture	Preferred heavily grazed pastures for nesting over lightly or moderately grazed pastures
Prescott 1997	Alberta	Cropland, hayland, mixed-grass pasture, shrubland, tame pasture, woodland	Were present in native mixed-grass, tame pastures, hayland, sandhill prairie, fallow cropland, planted cropland, and shelterbelts
Prescott et al. 1993	Alberta	Cropland, DNC (idle seeded-native), mixed-grass pasture, tame pasture, wetland	Were common in delayed grazing pasture treatments, created wetlands, early summer-grazed native pastures, spring-grazed tame pastures, deferred (after 15 July) native pastures, and continuously grazed native pastures
Prescott and Murphy 1996	Alberta	Mixed-grass pasture, tame pasture	Frequency of occurrence was higher in native pastures than tame pastures; in native pastures, ordination results showed that the species appeared in areas with moderate cover diversity, short grass, and grass moderately uniform in height; principal component analysis showed that in native pastures the species reached highest abundance in short grass, with low values of forb/grass ratio; in tame pastures, highest abundances occurred in areas with low herbaceous biomass and uniform herbaceous height; in native pastures, preferred short, uniform grass; in tame pastures, preferred little herbaceous biomass and uniform herbaceous height
Prescott and Murphy 1999	Alberta	Cropland, DNC (idle seeded-native/tame)	Preferred cropland and newly seeded DNC
Prescott and Wagner 1996	Alberta	Mixed-grass pasture, tame pasture	Were abundant in mixed-grass and tame pastures

Pylypec 1991	Saskatchewan	Burned mixed-grass, idle mixed-grass	Present in low numbers in burned and unburned areas
Renken 1983	North Dakota	DNC (idle tame), idle mixed-grass, mixed-grass pasture	Occurred only in grazed areas; used plots had less grass and forb cover than unused plots; used areas had 45% grass cover, 13.0% forb cover, 99% litter cover, 0.7% shrub cover, 1.0% bare ground, effective vegetation height of 5 cm, and 1.6 cm litter depth
Renken and Dinsmore 1987	North Dakota	DNC (idle tame), idle mixed-grass, mixed-grass pasture	Were observed in grazed plots, but were absent from DNC or idle
Rotenberry and Wiens 1980	Colorado, Kansas, Montana, Nebraska, Oklahoma, Oregon, South Dakota, Texas, Washington, Wisconsin, Wyoming	Idle mixed-grass, idle shortgrass, idle shrubsteppe, idle tallgrass, montane meadow	Abundance was negatively correlated with percent forb cover, maximum vegetation height, effective vegetation height, height of emergent forb/shrub cover, horizontal variation in forb and shrub height, and horizontal variation in the distance to the nearest forb or shrub
Ryder 1980	Colorado	Shortgrass pasture	Were more abundant on heavily summer-grazed areas than on lightly or moderately grazed areas; nests often were situated near cowpies
Ryder and Cobb 1969	Colorado	Idle, shortgrass pasture	Were present along roadsides; favored heavily grazed pastures
Sample 1989	Wisconsin	Burned tallgrass, cropland, DNC (idle	Were common in corn and soybeans and occurred in all agricultural habitats; used areas with an average

		seeded-native, idle tame), idle, idle seeded-native, idle tallgrass, idle tallgrass/tame, idle tame, tame hayland, tame pasture, tame savanna pasture, wet meadow, wet-meadow pasture	of 0.4% woody cover, 70% herbaceous cover, 10% litter cover, 21% bare ground, 57 cm maximum vegetation height, and 26 cm vegetation height/density; density was negatively associated with percent woody cover 0-3 m tall, total percent woody cover, number of dead stems 0-3 m tall, total number of dead stems, maximum vegetation height, percent cover of standing residual vegetation, percent cover of prostrate residual vegetation, high density prostrate residual vegetation (proportion of quadrats with high density prostrate residual was 0.1), and plant species richness; density was positively associated with low density prostrate residual vegetation (proportion of quadrats with low density prostrate residual was 0.5) and bare ground
SWCC 1997	Saskatchewan	Mixed-grass pasture	Occurrence was positively associated with number of contacts of narrow-leaved (<5 mm wide) grasses $\leq$10 cm high and negatively associated with vegetation height
Shutler et al. 2000	Saskatchewan	Cropland, DNC (idle seeded-native, idle seeded-tame), wetland	Were more abundant in cropland on conventional, minimum-tillage, and organic farmland than in DNC; presence was negatively related to number of wetlands within 2.8 km^2 of point counts and by area of woody vegetation; were not detected in wetlands or wetland margins
Skinner 1974, 1975	Missouri	Idle tallgrass, idle tame, tallgrass hayland, tallgrass pasture, tame hayland, tame pasture	Occurred only in grazed plots; were more common in heavily grazed areas; avoided vegetation >30 cm in height; used areas of bare ground produced by cattle and American bison disturbances
Skinner et al. 1984	Missouri	Burned tallgrass, idle	Were common only on very short (about 70% cover

		tallgrass, tallgrass hayland, tallgrass pasture, tame pasture	at 1 cm, about 5% cover at 25 cm) grasslands, which were usually heavily grazed
Speirs and Orenstein 1967	Ontario	Cropland, idle, pasture, tame hayland	Occurred in recently cultivated fields and bare areas
Stewart 1975	North Dakota	Cropland, idle shortgrass, mixed-grass hayland, mixed-grass pasture, tame hayland	Were found in shortgrass, intensively grazed mixed-grass, mowed mixed-grass, mowed tame haylands, cropland, stubble, bare cultivated fields, and recently planted fields; nested in depressions on bare or sparsely vegetated ground
Strong 1971	Colorado	Idle, shortgrass pasture	Ground nests were in moderately to heavily grazed native grassland
Sutter and Brigham 1998	Saskatchewan	Mixed-grass pasture, tame pasture	No significant difference in abundance was found between mixed-grass prairie and tame stands of crested wheatgrass
Sutter et al. 2000	Saskatchewan	Mixed-grass pasture	Abundance in mixed-grass prairie was not significantly different along roadsides than along trailsides
Wiens 1970	Colorado	Shortgrass pasture	Preferred heavily winter-grazed over heavily summer-grazed plots; occupied sites on the heavily winter-grazed plot had the following average vegetation values: 2.2 contacts/10 cm interval vertical density, 1.1 cm effective height of vegetation, 0.3 cm litter depth, 27% litter cover, 80% grass cover, 2% forb cover, 2.5% woody plant cover, 7% cactus cover, 18% bare ground cover, and 0% rock cover; occupied sites on the heavily summer-grazed plot had the following average vegetation

			characteristics: 1.9 contacts/10 cm interval vertical density, 0.3 cm effective vegetation height, 0.2 cm litter depth, 19% litter cover, 81% grass cover, 0% forb cover, 0% woody plant cover, 2% cactus cover, 19% bare ground cover, and 0% rock cover
Wiens 1973	Colorado, Montana, New Mexico, Oklahoma, South Dakota, Texas	Idle mixed-grass, idle shortgrass, mixed-grass pasture, semidesert shrubsteppe pasture, shortgrass pasture, tallgrass pasture	Preferred sites with short grass and emergent vegetation, and moderate heterogeneity; at the Colorado site, used areas where forbs and woody vegetation were sparse, and where vertical aspect of vegetation was not very well-developed; mean vegetation values for used areas in heavy winter grazed areas were as follows: 82% grass cover, 10% forb, 3% woody, 1% cactus, 16% bare ground, and 0% rock; stem density in individuals/m^2: 264 forb, 45 woody, and 113 cactus; 100% open sky at ground level, 0.31 cm litter depth, 23% litter cover; 1.5 heterogeneity index (based on maximum and minimum values for vertical vegetation density, and served as a measure of both vertical and horizontal patchiness), 8 cm emergent vegetation height, 2.4 vertical density; 98% density <10 cm, and 0.7 cm effective height
With and Webb 1993	Colorado	Shortgrass pasture	Nests experienced complete solar exposure at midday and 45% total exposure per day; most nests had a northeast orientation relative to vegetation or the structure near the nest; nested near cowpies

* In an effort to standardize terminology among studies, various descriptors were used to denote the management or type of habitat. "Idle" used as a modifier (e.g., idle tallgrass) denotes undisturbed or unmanaged (e.g., not burned, mowed, or grazed) areas. "Idle" by itself denotes unmanaged areas in which the plant species were not mentioned. Examples of "idle" habitats include weedy or fallow areas (e.g., oldfields), fencerows, grassed waterways, terraces, ditches, and road rights-of-way. "Tame" denotes introduced plant species (e.g., smooth brome [*Bromus inermis*]) that are not native to North American prairies. "Hayland" refers to any habitat that was mowed, regardless of whether the resulting cut vegetation was removed. "Burned" includes habitats that were burned intentionally or accidentally or those burned by natural forces (e.g., lightning). In situations where there are two or more descriptors (e.g., idle tame hayland), the first

descriptor modifies the following descriptors. For example, idle tame hayland is habitat that is usually mowed annually but happened to be undisturbed during the year of the study.

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